On the Origin of Unit Alignment in Superdeformed Bands in A≈190 Nuclei

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Since the first observation (almost 10 years ago) of identical bands in superdeformed (SD) nuclei many experimental and theoretical studies have been performed. However, it remains an open question whether their occurrence requires new physics, or, as others have suggested, they arise due to a series of "accidental cancellations". Here, we present the main conclusions of an experimental and theoretical study of the inertias and alignments of A∼190 SD bands.

The alignment and the moment of inertia studies indicate that A∼190 SD bands tend to distribute themselves among the following three groups characterized by their alignments (Fig. 1) and the number of unpaired nucleons; (i) even-even (0-quasiparticle), (ii) odd-even/even-odd ("singly" blocked, either proton or neutron), and (iii) odd-odd ("doubly" blocked, both proton and neutron). The alignments cluster around integer values ($i \approx -1, 0, 1$), but the peaks are not well separated suggesting that the "strict" quantized alignments observed in some nuclei are not a systematic feature of all A∼190 SD bands. The appearance of three groups in the alignment plot arises from small differences in the rotational properties below $\hbar\omega \sim 0.25$ MeV; ie. a separation of the dynamic moment of inertia ($\Im^{(2)}$) curves. The Hartree Fock Bogolyubov (HFB) and Total Routhian Surface (TRS) calculations performed in this study reproduce these global properties and give the distribution of bands into three groups (Fig. 1). However, they are not able to reliably reproduce the observed identical bands.

Microscopic HFB calculations indicate the alignments (differences in $\Im^{(2)}$) do not have a unique source; both core (pair-blocking) and quasiparticle effects contribute to the final value. Pair-blocking refers to the change (increase) in the moment of inertia due to reduced pairing caused by unpaired nucleons. The relative importance of the two contributions is correlated with the nature of the odd quasiparticle; for high-K orbitals the alignment comes mainly from the core.

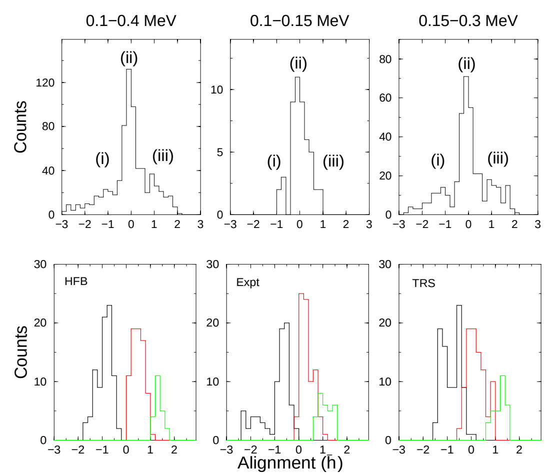

Figure 1: Upper: Alignment of 57 experimental A∼190 SD bands, relative an average reference, for three frequency ranges chosen to correspond to the full range, and to either just below the point or in the range where the alignment is most pronounced. Lower: Alignment of 14 experimental, HFB, and TRS bands, derived over the full frequency range relative to their own average reference. Separate histograms are shown for even-even (black), odd-even/even-odd (red) and odd-odd (green) SD bands.